1 Hadronization

Hadronization is the fundamental process in which the partonic medium converts into hadrons. It includes both the dressing of quarks from their bare masses, thus breaking the approximate chiral symmetry, and the confinement of quarks into colorless hadrons. Due to its non-perturbative nature, the hadronization process is not well understood. Heavy ion reactions present an opportunity to study this process in the nucleus (using $d + A$ collsions) and in the dense QGP medium ($A + A$ collisions). The detailed understanding of hadronization also plays a crucial role for isolating signatures sensitive to the QGP properties and evolution from those which are dominated by the later reaction stages. A conclusive experimental evidence for hadronization occuring from thermalized quark and gluon distributions can be interpreted as an evidense for QGP formation.

One of the theoretical milestones of the first several years of the RHIC program was the development of the recombination plus fragmentation model of hadronization based on the observation that in an environment with a high density of partons recombination always dominates over fragmentation for an exponentially falling parton spectrum, but that fragmentation wins out eventually, when the spectrum takes the form of a power law. Thus hadron production in the intermediate p_T region (2–5 GeV/c), is likely to be dominated by recombination.

The major RHIC discoveries that prompted the development of recombination models of hadronization are the enhanced baryon-to-meson ratios at intermediate p_T that can not be attributed to parton fragmentation, the baryon/meson differences in the suppression patterns of hadron production and the empirical scaling of elliptic flow strength with the number of quarks in the hadrons. The success of recombination models in describing the observed baryon/meson differences gives strong evidence for the partonic nature of the medium formed at RHIC. Surprisingly, experimental studies of jet-correlations using identified baryon or meson triggers in the intermediate p_T region show little or no particle species dependence, which rules out recombination from a pure thermal source. For the recombination picture to remain valid, at least one of the quarks in the baryon has to come from the fragmentation of a hard-scattered parton and thus preserve the jet-like correlations between the final hadrons.

A detailed study of the interplay of recombination and fragmentation will require high precision data on identified particle distributions covering $p_T \approx 8$ GeV/c. Of particular interest will be data on multi-strange hadrons and resonances. Resonances have been predicted to violate the elliptic flow scaling law, allowing for further insight into the strength of hadronic final state interactions. In addition, the measurement of dynamical two-particle correlations will help to constrain the recombination formalism and the transition to fragmentation at high p_T. Enhanced PID capabilities will become available after the planned STAR and PHENIX upgrades, while the RHIC II luminosity is needed to obtain statistically significant elliptic flow and correlation results involving rare particle species.

There have been attempts to describe the baryon/meson effects through the existence of gluon junctions. This approach poses the fundamental question about the nature of the baryon. Detailed baryon number versus charge transport measurements are needed to enable the experimental test if gluons have a contribution to the baryon number. A full account for the baryon number transport requires the detection of neutrons and anti-neutrons, in addition to the already existing capabilities to detect charged and weakly decaying neutral hadrons. Such capabilities are not included in the present STAR or PHENIX upgrade program. An upgrade of BRAHMS with a small area hadronic calorimeter combined with the already available PID for charged hadrons could enable the measurements of baryon and charge transport over a broad kinematic range. Due to the small acceptance, these measurements can not be possible without RHIC II luminosity.

************ ONE FIGURE COMES HERE. 2 panels: left R_{AA} for baryons/mesons , right v2/per quark - baryons/mesons. ***********